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Pacific Region

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RECOVERY POTENTIAL ASSESSMENT FOR WEST COAST TRANSIENT KILLER WHALES

Figure 1 Photo by Dr. Lance Barrett-Lennard

Figure 2. Bathymetric map of the Pacific coast of Canada

Context :

*West Coast Transient Killer Whales (*Orcinus orca*) are one of three different assemblages of killer whales in northeastern Pacific Canadian waters. They were first assessed by COSEWIC in 1999 as Special Concern but were reassessed in 2001 as Threatened. This population of killer whales was listed on Schedule 1 under the* Species at Risk Act *as Threatened in 2003. A draft Recovery Strategy for transient killer whales was prepared by DFO in 2007, but insufficient information was available to set quantitative recovery goals in that document.*

SUMMARY

- Mammal-eating 'transient' killer whales off Canada's Pacific coast are listed as Threatened under the *Species-at-Risk Act*.
- This Recovery Potential Assessment for West Coast Transient (WCT) killer whales is intended to provide a scientific basis for recovery planning and is based on an archive of 219 individually photo-identified WCT whales collected from 1479 sightings between 1974 and 2006.

- These analyses indicate that the WCT population grew rapidly from the mid-1970s to mid-1990s as a result of a combination of high birth rate, survival, as well as greater immigration of animals into the nearshore study area. The rapid growth of the WCT population in the mid-1970s to mid-1990s coincided with a dramatic increase in the abundance of the whales' primary prey, harbour seals, in nearshore waters. Population growth began slowing in the mid-1990s and has continued to slow in recent years.

- The recent slowing of WCT population growth suggests a carrying capacity of 250 to 300 whales. The Potential Biological Removal (PBR) is estimated at only 1.60 animals/year implying that the population would decline if human-induced mortality exceeds this rate.

INTRODUCTION

In April 1999, the northeastern Pacific transient killer whale population was designated Special Concern by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC). The status of this population was reassessed in 2001 based on an existing status report (Baird 2001) and an addendum containing updated information (Trites and Barrett-Lennard 2001), and uplisted to Threatened in November 2001. Reasons for this designation were that it is a "small population that eats marine mammals", and "individuals have high levels of toxic pollutants". This population became legally listed on Schedule 1 with the proclamation of the *Species-at-Risk Act* (SARA) in 2003.

As required by SARA, a Recovery Strategy for Transient Killer Whales in Canada was prepared by Fisheries and Oceans Canada (DFO) and posted for public comments in 2007 (Fisheries and Oceans Canada 2007). Once accepted by the Minister of Fisheries and Oceans, an Action Plan will be developed to achieve recovery goals and objectives developed in the Recovery Strategy.

DFO Science has recently established a Recovery Potential Assessment (RPA) process to provide information and science advice for meeting SARA requirements for listed species, and for deciding whether to add species to the list. A RPA is intended to assess current population status, identify the scope of human induced mortality, and describe the characteristics and availability of critical habitat. At the time the Recovery Strategy for transient killer whales was drafted, an RPA was not available. Since that time an assessment of the recovery potential for WCT has been produced (Ford et al., 2007). The content of this document is largely based on that report.

Species biology

The killer whale *Orcinus orca* is the largest member of the family Delphinidae and one of the most widely distributed mammals in the world. It occurs in all the world's oceans and most seas, but is most commonly found in coastal waters in high latitude regions. The global population is estimated to be at least 50,000 (Forney and Wade 2006). The killer whale is the apex marine predator in that it has no natural predators, and is capable of feeding on a great diversity of prey, from the largest whales to small schooling fish. However, individual populations of killer whales may have highly specialized foraging strategies and diets.

Three distinct assemblages of killer whales have been described in coastal waters of the north-eastern Pacific Ocean. These assemblages, named *transient*, *resident* and *offshore*, differ in diet and foraging behaviour, acoustic behaviour, morphology, and genetic characteristics. Despite having overlapping ranges, these assemblages do not mix and are thus socially and

reproductively isolated from each other. Transient killer whales specialize on marine mammal prey, though they occasionally kill and eat seabirds as well. Despite decades of field observations, WCT killer whales have never been observed to prey on fish, whereas resident or offshore killer whales have never been observed to prey on marine mammals. These foraging specializations appear to be fixed behavioural traits maintained by cultural transmission within populations.

The WCT population is the only one known to be present in Canadian waters and is distributed throughout coastal waters of British Columbia. This population is estimated to comprise 219 whales in 1999, based on long-term photo identification studies, though long gaps between sightings of some individuals added considerable uncertainty to this estimate (Ford and Ellis 1999). An additional 100 or so transient killer whales identified off the central coast of California (Black et al. 1997) were in the past considered to be an extension of this population because of acoustical similarities and occasional mixing with WCT individuals in BC waters (Ford and Ellis 1999). However, a recent reassessment indicated that the available evidence was insufficient to warrant inclusion of these whales in the WCT population (Fisheries and Oceans Canada 2007). This is also the case for Gulf of Alaska transients, which are seen occasionally within the range of WCTs but have only been observed to travel in association with WCTs on one occasion.

ASSESSMENT

Killer whales are long-lived animals that have a low reproductive potential. Although few life history parameters are yet available for transient killer whales, values for resident killer whales presented in Olesiuk et al. (2005) may be generally representative. Survival patterns are typical of mammals, being U-shaped with highest mortality rates in very young (neonate) and very old age classes. Survival rates of juveniles and adults are high (0.97-0.99), particularly among mature females and during periods of population growth. During a period of growth in the northern resident killer whale population, females had a mean life expectancy (at age 0.5 yr) of 46 yrs and a maximum longevity of about 80 yrs. Males had a mean life expectancy of 31 yrs, with maximum longevities of 60-70 yrs.

The population dynamics of transient killer whales were estimated using capture-recapture models based on individual photo-identification data collected during 1479 encounters with WCT whales during 1974-2006 (Ford et al. 2007).

Trends and current status

Survival

The survival probability, pooled across all individuals was remarkably high, and relatively stable, across the study period. The average annual survival probability had an estimated median of 0.98 (95% probability interval = 0.95-0.99)

Recruitment

Recruitment was determined to be high for the first half of the time series and relatively low for the second half of the time series. Recruitment probability was divided for analysis into the four 8-year increments, starting in 1975. The recruitment probabilities for these time blocks were 0.09, 0.09, 0.04 and 0.03. During the final 6 years, when only new calves were documented, the average recruitment was 0.03 (0.01-0.07).

Sex specific survival / recruitment

Estimates of survival were relatively imprecise for calves and sub-adult males due to small sample sizes. Nonetheless, survival was notably high and stable for all age / sex classes. Estimates of average survival show the highest rate for adult females (0.98, 0.97-0.99) and juveniles (0.98, 0.95-0.99), with a slightly lower but similar rate for adult males (0.97, 0.94-0.98). The average survival rate was lower for sub-adult males (0.95, 0.87-0.98) and calves (0.92, 0.82-0.97). However, it is clear that recruitment of new non-calves into the population was negligible during the second half of the time series, with almost all the additions coming as first year calves. There is some evidence of a small level of recruitment for other age classes during the first half of the time series, indicating the recruitment of new non-calves into the population. This could reflect movement of non-calf individuals into the study area. However, this may partly reflect the discovery of new individuals in the population with increasing geographical coverage over time.

Population growth

High survival and recruitment has led to a growing population. The average annual population growth rate was 1.06 (0.99-1.23), indicating growth of 6% per year. However, there is also evidence of a recent slowing in population growth, mirroring the decline in recruitment during the second half of this time series. This can be seen in the average estimates for growth over the four 8-year increments, starting in 1975: 1.08 (0.96- 1.50); 1.11 (1.02-1.29); 1.02 (0.98-1.10); and 1.02 (0.98-1.07). Growth at the start of the time series was therefore rapid, tracking relatively high rates of recruitment. In the latter half of the time series there was a decreasing growth rate which corresponds to observed decrease in recruitment.

Population abundance

Abundance estimates produced from capture probabilities were consistent with these estimates of population growth rate derived from demographics, showing a growing population but a decreasing rate of population growth. Population size was initially very low (posterior median = 24, 95% probability interval = 11-53) in 1974, grew rapidly for the first half of the time series, but growth appears to have slowed towards the end of the series. The population estimate at the end of the time series was 243 (95% probability interval = 180-339) in 2006.

Population growth was described using a stochastic logistic model, in which the rate of population growth is assumed to decrease linearly with increasing abundance. This density-dependent model defined an equilibrium point of K = 262 whales, which may be interpreted as the current carrying capacity for the WCT population. At the end of the time series the population appeared to be close to reaching this equilibrium point. A more thorough review of population status and trends can be found in Ford et.al. (2007).

Recovery potential

If, as the evidence suggests, WCTs are prey limited and are approaching the carrying capacity of their current range, the potential for future population growth is limited without an increase in prey densities. There is currently no indication of an increasing trend in populations of the WCT's most important prey species, with the exception of the Steller sea lion. Provided there is no decline in prey availability or unexpected source of increased mortality, the population recovery target in the Transient Killer Whale Recovery Strategy – "a stable abundance over the next five years" – is likely achievable. Recruitment in the WCT population has slowed over the past decade, but continued monitoring will be necessary to determine if this trend continues and whether survival decreases in the future due to density dependence. Killer whales are long-lived, upper trophic-level predators with a very low reproductive potential. They also have a

tendency to live in very small, behaviourally specialized and reproductively isolated populations. These factors make killer whale populations such as the WCTs highly vulnerable to even minor increases in levels of mortality.

Sources of harm

Since the live-capture of killer whales for public display ended in the mid 1970s, no directed takes of transient killer whales have been recorded in the region. Indiscriminate shooting of killer whales, once common on the coast, now appears to be very rare (Ford et al. 2000). However, a variety of sources of mortality to WCT killer whales could potentially result from human activities. These threats are described in detail in the Recovery Strategy (Fisheries and Oceans Canada 2007), and are summarized below. It should be noted that some of these threats have not been demonstrated to be a direct cause of mortality in WCTs, or in killer whales generally, and may not represent a lethal risk on their own. However, it is possible for multiple stressors to act synergistically to cause stronger negative and possibly lethal effects.

Contaminants

Killer whales in coastal waters of the northeastern Pacific carry significant concentrations of Persistent Bioaccumulating Toxins (PBTs) in their tissue. Of greatest concern are polychlorinated biphenyls (PCBs), which are found at extremely high concentrations in WCT killer whales due to their consumption of marine mammals that are already contaminated with PCBs (Ross et al. 2000, 2004). These compounds are not typically acutely toxic, but can potentially have chronic, slow-acting effects as 'hormone mimics' or 'endocrine disruptors'. Although health effects have not been demonstrated in killer whales, high levels of PCBs in harbour seals have been associated with immuno-suppression and endocrine disruption (Mos et al. 2006). Although PCB levels are declining in the environment, recent models suggest that it will take decades before PCB levels in killer whales decline below the thresholds for adverse effects seen in other species (Hickie et al. 2007).

Also of concern are rapidly increasing levels of polybrominated diphenyl ethers (PBDEs), which have recently become widely used as flame retardants in a variety of products. As with PCBs, the potential direct effect of PBDEs on transient killer whale health is not clear, there is growing evidence of endocrine disruption and immunotoxicity in other species (Fisheries and Oceans Canada 2007).

Biological Pollutants

Transient killer whales may be at heightened risk to the impacts of exotic diseases or 'biological pollution' due to their consumption of marine mammal prey. Transients may be exposed to pathogens such as viruses and bacteria that are endemic to their mammalian prey or from terrestrial sources, such as domestic pets or livestock. Biological pollutants may have direct effects by causing disease in transient killer whales, which may be predisposed to increased risk or severity of infection due to the immunotoxic nature of PBTs found at high levels in transients. Biological pollutants and pathogens could also affect transients indirectly through mortality and subsequent reduced availability of prey species. For example, a widespread epidemic of *Morbillivirus* among harbour seals, such as that which caused mass mortalities of seals in northwestern Europe, could have serious consequences for WCT killer whales (Fisheries and Oceans Canada 2007).

Acoustic Disturbance

There has been increasing concern in recent years about the potential effects of underwater noise on cetaceans. Acoustic disturbance can be of two types: chronic and acute. Chronic noise

is primarily associated with motorized vessel traffic of all types, from commercial shipping to whale watching. Chronic noise can result in masking of communication signals used for social contact or behavioural coordination, or interfere with echolocation signals used for navigation and discrimination. Transient killer whales often forage in silence and may rely on passive listening to locate their prey (Barrett- Lennard et al. 1996). Masking effects of increasing background noise could thus reduce their foraging efficiency. Although there is no direct evidence of the effects of high intensity sounds on transient killer whales, by inference from other cetacean species, detrimental effects might be expected.

Physical Disturbance

Vessels moving in close proximity have the potential to affect transient killer whales by disrupting behaviours. Although no studies have focused on transients specifically, resident killer whales have been shown to alter their swimming behaviour when approached by boats (Williams et al. 2002). With the increased intensity of whale watching activity in the vicinity of WCT killer whales in some areas, there is a potential for vessels to disrupt hunting behaviour, thereby reducing overall foraging success. Transient attacks on marine mammals are often prolonged and involve energetic, high-speed swimming, and vessels in close proximity can cause the whales to abandon their attack, or provide the prey item with a refuge to escape from the attacking whales.

Collision with Vessels

Killer whales are at some risk of injury or mortality as a result of being struck by boats or ships. Although there are no reported cases of transient killer whales being struck by vessels, four such incidents involving resident killer whales have been documented in recent years, two of which were fatal. It is not clear whether differences in swimming and diving patterns between the two types of killer whales make transients more or less vulnerable than resident killer whales to vessel strikes.

Toxic spills

There is evidence that killer whales do not avoid toxic spills, as indicated by the behaviour of both residents and transients during the Exxon Valdez oil spill in 1989 in Prince William Sound, Alaska (Matkin et al. 1999), and of residents during a recent diesel spill in August, 2007, in Robson Bight, B.C. In the case of the Exxon Valdez incident, exposure to oil was associated with unprecedented mortality of both transient and resident whales, which probably died from inhalation of toxic petroleum vapours (Matkin et al. 1999). Expanded oil tanker traffic or hydrocarbon exploration and extraction off the west coast would increase the risk of toxic spills and potential injury or mortality to WCT whales.

Changes in Prey Availability

Transient killer whales are marine-mammal specialist predators, and potentially could be affected by major changes in prey availability. In western Alaska, there have been sharp declines in abundance of harbour seals, sea lions, and fur seals, and it has been hypothesized that these declines caused transient killer whales in that region to switch to sea otters, a less desirable prey species (Estes et al. 1998). Because of their reliance on highly-specialized foraging strategies that are maintained by social learning and cultural transmission across generations, killer whales likely have a limited ability to shift to efficient hunting of novel prey species. Because WCT killer whales feed on a variety of different marine mammal species, they may not be vulnerable to minor fluctuations in abundance of a particular prey species. However, a wide-scale decline in multiple prey species, as took place in western Alaska, could have significant consequences for WCTs. Marine mammal prey species in the range of WCTs are currently subjected to relatively low levels of human-related mortality, and no significant

changes in such mortality rates are anticipated. However, a major change in the marine ecosystem structure off the west coast, possibly resulting from over-harvesting of fish stocks, could affect transients indirectly through effects on their prey.

Scenarios for Mitigation and Alternatives to Activities

This section of the RPA is intended to provide an inventory of all feasible measures to minimize or mitigate the impacts of human activities on WCT killer whales and their habitat. Much of this is addressed in the draft Recovery Strategy for West Coast Transient Killer Whales (Fisheries and Oceans Canada 2007) and in a recent draft assessment of risk to critical habitat identified for resident killer whales (Lee et al. 2007). The following is extracted from these draft documents and presented here for information. Note that these generally include only mitigation measures available in Canadian waters.

Noise Mitigation

Military sonar

The Department of National Defence (DND) has established protocols to protect marine mammals from disturbance and/or harm from the use of military active sonar. Maritime Command Order 46-13, for marine mammal mitigation, is to avoid transmission of sonar any time a marine mammal is observed within the defined mitigation avoidance zone, which is established specific to each type of sonar. Ship's personnel receive training in marine mammal identification and detection. All foreign vessels are subject to Canadian regulations while in Canadian waters. However, concern remains regarding compliance by foreign vessels with Canadian regulations and the effectiveness of these mitigation protocols.

Seismic air guns

Currently few industrial or scientific seismic surveys are being conducted in western Canadian waters. Some projects involving seismic surveying trigger screening under the *Canadian Environmental Assessment Act* (CEAA), while others are reviewed regionally by DFO. In 2008, DFO issued a Statement of Canadian Practice on the Mitigation of Seismic Noise in the Marine Environment (DFO 2008), to address concerns regarding the potential impact of seismic use on marine mammals and other marine life. In the Pacific Region, each proposed seismic survey is reviewed by DFO marine mammal experts and mitigation measures are developed based on the species of concern in the area of the survey for each project.

Construction noise

Mitigation protocols to prevent exposure of cetaceans to noise associated with construction activities such as dredging and pile driving in the Pacific Region are similar to those for seismic air guns.

Chronic noise

There is currently little mitigation of chronic noise in the marine environment that originates from shipping and other marine vessel traffic. Of particular concern is noise caused by whale-watching vessels that are frequently concentrated in prime transient killer whale foraging habitat (e.g., off Victoria, B.C.). However, whale-watching guidelines developed jointly by DFO and the US National Oceanic and Atmospheric Administration have served to restrict the distance and speeds at which boats can approach killer whales, which helps to reduce the level and extent of noise ensonification in the vicinity of whales.

Toxic Spills

The *Transportation of Dangerous Goods Act* regulates handling and transport of toxic substances within Canada, and numerous international, federal and provincial measures are in place for the prevention and management of toxic spills (e.g. Canadian/U.S. spill response plans for trans-boundary waters, *Oil and Gas Operations Act*, BC EMA). Despite such regulation and preventative measures, spills are frequent along the coast of British Columbia, but most are very small and localized and do not present a major risk to WCT habitat.

Chemical Pollution

Numerous national and international regulations and agreements govern the manufacturing and application of many kinds of PBTs, particularly the so-called legacy PBTs such as PCBs. The Stockholm Convention on persistent organic pollutants (POPs) and other UN Protocols aim to reduce global levels of legacy PBTs. Manufacture and availability of toxic chemicals in Canada are managed via listing under Schedule 1 of the CEPA and the BC *Environmental Management Act* (EMA) has regulations in place for management of contaminants in industrial and municipal effluents and outflows. The *Fisheries Act* (S. 36) prevents discharge of toxic substances into fish habitat(s), mitigating toxic threats to killer whale prey. Environment Canada is revising their proposed Risk Management Strategy for Polybrominated Diphenyl Ethers, under the *Canadian Environmental Protection Act*. This strategy supports the ban of several (but not all) of the forms of PBDEs that are known to bioaccumulate in killer whales. Regulations on manufacture of chemicals and vectors of contamination (e.g. sewage outflows) manage toxins in runoff in British Columbia. The BC Ministry of Environment's storm-water planning, as well as non-governmental programs are in place for education on toxic runoff. For agriculture, the *Fertilizers Act* manages chemicals and the BC EMA Agricultural Waste Control regulation and Best Agricultural Waste Management Plans manage industry practices specifically.

Habitat requirements

West Coast Transient killer whales occupy a very extensive range. They travel widely throughout all coastal waters between about 47°N and 58°N latitudes, which corresponds to a straight-line distance of 1600 km along the west coast. Although the extent of their range in offshore waters is unknown, WCT whales have been encountered up to 40 km from shore. Transients spend the majority of their time foraging for marine mammal prey, which likely play a major role in determining movement patterns. WCTs may be found year-round in all parts of their overall range, but they rarely remain in any one location for long. Because their hunting strategy depends on stealth, it is likely more profitable to keep moving once potential prey in an area are alerted to their presence.

Threats to Habitat

In this discussion, direct threats to individual whales, such as physical disturbance or vessel collisions, and threats to prey abundance, are differentiated from threats to habitat. As such, the main threats to WCT habitat are underwater noise and toxic spills. Chronic noise from shipping, for example, has the potential to interfere with foraging success by masking sounds needed to detect and localize prey, especially in confined waterways such as the Inside Passage. Highly industrialized and therefore noisy areas such as ports and harbours may be avoided by transient killer whales, but these are very small areas relative to the whales' entire range. High intensity acute noise from military sonar or seismic exploration could ensonify large areas of habitat, potentially disturbing whales or displacing them from important foraging areas. Major toxic spills, including catastrophic oil spills, could cause extensive contamination of habitat, in

addition to direct physical harm to transient killer whales. This risk can be anticipated to increase if oil tanker or barge traffic increases or oil exploration and extraction takes place in WCT habitat. Other forms of pollution that may degrade habitat quality include wastewater effluent near urban areas, which may contain a variety of chemical pollutants, and pesticides and biological pollutants carried in runoff in agricultural areas.

CONCLUSIONS AND ADVICE

An overall recovery goal and set of specific recovery objectives were developed in the draft Transient Killer Whale Recovery Strategy (Fisheries and Oceans Canada 2007). Without any objective means of estimating historical abundance, carrying capacity or biological limiting factors for WCTs, it was not possible to set a quantitative population abundance target for recovery. Instead, the goal of the Recovery Strategy is:

> *To attain long-term viability of the West Coast transient killer whale population by providing the conditions necessary to preserve the population's reproductive potential, genetic variation, and cultural continuity.*

Provided there is no decline in prey availability or unexpected source of increased mortality, it can be anticipated that the population recovery target of the Transient Killer Whale Recovery Strategy – a stable abundance over the next five years – is achievable

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